
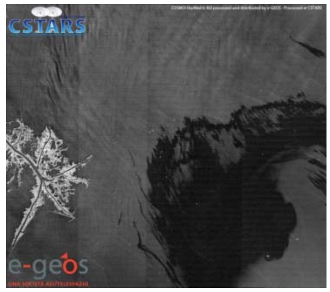

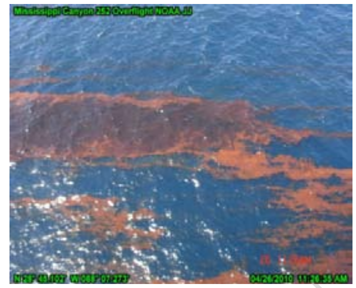

Deepwater Horizon Dispersant Use Meeting Report
May 26-27, 2010

Report Issued by: Coastal Response Research Center
University of New Hampshire
June 4, 2010

University of New Hampshire
Coastal Response Research Center
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

FOREWARD

The Coastal Response Research Center, a partnership between the National Oceanic and Atmospheric Administration (NOAA) Office of Response and Restoration (ORR) and the University of New Hampshire (UNH), develops new approaches to spill response and restoration through research and synthesis of information. The Center's mission requires it to serve as a hub for research, development, and technology transfer to the oil spill community. The CRRC has a long history of overseeing research and development on the efficacy and effects of dispersed oil and convening dispersant related workshops with stakeholders from the oil spill community. At the request of NOAA, the center held a meeting on May 26 and 27 at the Lod Cook Alumni Center on the Louisiana State University (LSU) campus in Baton Rouge focusing on the use of dispersants in the Deepwater Horizon (DWH) incident in the Gulf of Mexico.

The meeting, titled "Deepwater Horizon Dispersant Use Meeting", was attended by over 50 scientists, engineers and practitioners from numerous organizations, including: U.S. Coast Guard (USCG), Mineral Management Service (MMS), National Oceanic and Atmosphere Administration (NOAA), industry, state government, and academia. The ultimate goal of this meeting was to: (1) Provide input to the Region 4 and Region 6 Regional Response Teams (RRTs) on the use of dispersants going forward in the DWH incident; and (2) Identify possible monitoring protocols in the event of continuing aerial and subsurface dispersant application

This report contains input and probable monitoring protocols for the RRTs along with the notes from the breakout groups, a participant list, the meeting agenda and powerpoint presentations. I hope you find the input helpful and the discussion illuminating. If you have any comments, please contact me. The Center hopes that this report will be of use to the RRTs as they move forward with the Deepwater Horizon response and to the greater oil spill community and the nation.

Sincerely,

Nancy E. Kinner, Ph.D.
UNH Co-Director
Professor of Civil/Environmental Engineering

Acknowledgements

The Coastal Response Research Center gratefully acknowledges the CRRC authors of this report: Nancy E. Kinner, Joseph J. Cunningham, Zachary E. Magdol, Heather R. Ballestero, and Tyler M. Crowe. The Center acknowledges the time and effort provided by the participants in the workshop, whose contributions have been synthesized into this report. In addition, the Center acknowledges the thoughtful input and comments received from the reviewers of the draft report: Craig Carroll (USEPA, RRT6); Richard Coffin (US-NRL); William Conner (NOAA, ORR); James Hanzalik (USCG); Charlie Henry (NOAA, ORR); Bruce Hollebone (Environment Canada); Mark Mjoness (USEPA); Robert Pond (USCG); Jeep Rice (NOAA, NMFS); Terry Wade (Texas A&M University); Al Venosa (USEPA). The Center also gratefully acknowledges the help of Professor Donald W. Davis (LSU – Emeritus), David Nieland (LSU, Sea Grant) and the staff of the Lod Cook Hotel and Alumni Center at LSU for their help in making this meeting happen in less than 96 hours.

The following individuals helped plan this meeting: Carl Childs (NOAA OR&R); Tom Coolbaugh (Exxon Mobil); Dave Fritz (BP); Kurt Hansen (USCG, R&D center); Charlie Henry (NOAA ORR); Bruce Hollebone (Environment Canada); Ken Lee (Fisheries and Oceans, Canada); and Al Venosa (USEPA). The Center staff for this meeting consisted of: Heather Ballestero; Joseph Corsello; Tyler Crowe; Joseph Cunningham; Michael Curry; Eric Doe; Nancy Kinner; Zachary Magdol; and Kathy Mandsager. The Center also gratefully acknowledges Bruce Hollebone and Nichole Rutherford (NOAA OR&R) for serving as group leaders.

Citation:
Coastal Response Research Center. 2010. Deepwater Horizon Dispersant Use Meeting Report. University of New Hampshire, Durham, NH, 18 pp and appendices.

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I. INTRODUCTION

At approximately 2200 hours on Tuesday, April 20, 2010, the U.S. Coast Guard (USCG) received a report that the mobile offshore drilling unit (MODU) Deepwater Horizon (DWH) located in the Mississippi Canyon lease site 252 (approximately 42 miles southeast of Venice, LA), had experienced an explosion and was on fire. The MODU sunk on April 24, scattering debris from the riser pipe across the ocean floor in ~5,000 feet water. It became clear with a few days that the blowout preventer was not functional and oil was leaking into the water from more than one location on the broken riser.

Within hours of the incident, the USCG responded and began Search and Rescue (SAR) and environmental response operations. The release is relatively close to sensitive nearshore coastal habitats and wetlands, and prevailing wind and waves drive the surface oil towards land. To prevent landfall of the oil, mechanical recovery techniques were used, including skimming, booming, and *in situ* burning. However, when poor weather conditions limited the effectiveness and suitability of mechanical recovery, dispersants were applied to disperse surface oil and prevent landfall. In early May, responders began injecting dispersants at the source of the release in order to prevent oil from reaching the surface. These techniques have largely been successful, and have reduced the amount of oil reaching the nearshore. Consequently, dispersant use, primarily aerial (surface) application and in the oil plume as it exits the riser (deep ocean application), has become a major response tool as the release has continued unabated. The response was declared a Spill of National Significance (SONS) on April 29, 2010, and recent reports from the Unified Command estimate that between 12,000 and 19,000 barrels of oil are released into the water every day, making the DWH incident the largest oil spill in U.S. history. More than 950,000 gallons of dispersant have been used thusfar in the response, and with completion of relief wells scheduled for August, 2010, there is potential for significant further release of oil and application of dispersant.

In the event continued dispersant use is necessary throughout the summer, the Regional Response Teams (RRTs) expressed interest in late May in convening a meeting of scientists and practitioners to discuss dispersant use and provide input to RRT 4 (MS, AL, FL, GA, SC, NC, TN, KY) and RRT 6 (LA, TX, OK, NM, AZ). The meeting, titled "Deepwater Horizon Dispersant Use Meeting" brought together ~50 participants to: (1) Provide input to the Region 4 and Region 6 Regional Response Teams (RRT) on the use of dispersants going forward in the DWH Incident; and (2) Identify possible monitoring protocols in the event of continuing aerial and subsurface dispersant application. Four breakout groups were established that discussed: (1) Efficacy and effectiveness of surface and deep ocean dispersants; (2) Physical transport and chemical behavior of dispersants and dispersed oil; (3) Exposure pathways and biological effects resulting from deep ocean application of dispersants; and (4) Exposure pathways and biological effects resulting from surface application of dispersants.

II. MEETING ORGANIZATION AND STRUCTURE

The meeting, held at Louisiana State University on May 26 and 27, 2010, consisted of plenary sessions where invited speakers gave an overview of dispersant use in past oil spills, as well as an overview of the DWH incident and the response to date (Appendix A). Four breakout groups discussed key aspects of dispersant use in the DWH response: (1) Dispersant Efficacy and Effectiveness; (2) Physical Transport/ Chemical Behavior of Dispersed Oil; (3) Biological Effects of Dispersants on Deep Ocean Species; and (4) Biological Effects of Dispersants on Surface Water Species. Meeting participants were selected by a planning committee comprised of government and international partners with expertise in dispersants and oil spill response and research; meeting participants (Appendix B) represented a wide range of interests and included representatives from federal, state and foreign governments, as well as industry and academia.

Breakout questions (Appendix C) were developed by the Center staff and the planning committee. The breakout groups (Appendix D) gave input to the RRTs on continued use of dispersants for the DWH response, the risks/benefits with this input, and possible monitoring protocols going forward. In addition, they determined what information was needed to give the input, whether it was available for the DWH incident, or could be gleaned using information from past experience or the literature.

As a starting point, the following guidance was given to the breakout groups: (1) Surface dispersant operations have only been used in pre-approved zones (3miles offshore, >10 m water depth). Most dispersants have been applied 20-50 miles offshore where the water is greater than 100 ft deep; (3) Footprint of surface dispersant application is relatively small; (4) The body of water in which the dispersants are applied is constantly changing; (5) This meeting will focus on oil effects and dispersants in general (no discussions of specific dispersants, just general composition types).

III. MEETING RESULTS

A. Dispersant Efficacy and Effectiveness

Group A initially considered the efficacy and efficiency of surface and subsurface dispersant usage, however, on the second day of the workshop, the group was divided into two subgroups: Group A1 examined the efficacy and efficiency of subsurface dispersant usage, while Group A2 considered the efficacy and efficiency of surface dispersant usage.

Group members included:

Group Lead: Joseph Cunningham, Coastal Response Research Center
Recorders: Joe Corsello* & Eric Doe, University of New Hampshire
Tom Coolbaugh*, Exxon Mobil

Craig Carroll#, U.S. EPA
Per Daling, SINTEF
J.T Ewing*, Texas General Land Office
Ben Fieldhouse, Environment Canada
Chantal Guenette*, Canadian Coast Guard
Ann Hayward Walker*, SEA Consulting
Lek Kadeli#, U.S. EPA
Paul Kepkay, Bedford Institute of Oceanography - Fisheries & Oceans Canada
Ed Levine*, NOAA
Zhengkai Li, Bedford Institute of Oceanography - Fisheries & Oceans Canada
Joe Mullin*, Minerals Management Service
Duane Newell*, U.S. EPA Contractor
Bob Pond, USCG
Kelly Reynolds*, ITOPF
Al Venosa, U.S. EPA

*Group Members who assigned to Group A2
Group Members who were present for Day 1, but absent during Day 2

<u>Information Required to Make Assessment:</u>

- Spatial location of high, low, and non- effectiveness of dispersant
- Results of continuous water column monitoring, rather than discrete sampling events
- Extent of weathering from surface and subsurface oil
- GPS track routes to see if sampling boats are operating within the vicinity of aerial dispersant application tracks
- Properties of oil on the surface, including thickness and extent of weathering
- Properties of dispersant applied and untreated oil
- 3D visualization of plume
- Location, volume, and trends of plume
- Complete weathering profile
- Accurate volumetric oil flow rate and dispersant application range
- Effect of temperature and pressure on droplet formation and dispersion
- Estimates of contact time and mixing energy
- Dispersability of emulsion after multiple applications of dispersant

<u>Current State of Knowledge:</u>

- Oil emulsion (> 15 – 20% water) is non-dispersible
- Plume is between 1100 – 1300 m deep moving SW direction
- DWH oil high in alkanes, and has a PAH composition similar to South Louisiana reference crude
- Lighter PAHs (< C15) are likely volatilizing
- Viscosity of emulsified oil is between 5500-8500 centistoke
- Emulsion may be destabilizing (50-60%)
- Primary detection method, C3 (fluorometer), only gives relative trends – does not accurately measure concentration of total oil or degree of dispersion

Knowledge Gaps:

- Ability of emulsions to be dispersed with multiple applications of dispersant
- Appropriate endpoint for dispersant application (i.e., how clean is clean?)
- Effectiveness and appropriateness of other dispersant applications (i.e., boat, subsurface, airplane, helicopter)
- Actual range of oil flowrates and composition (i.e., percentage oil, methane)
- Size of plume (volumetric)
- Diffusion of oil components from dispersed droplets into the water column (e.g., aliphatics, PAHs)
- Chemical composition of the plume (i.e., presence of oil, dispersant)
- Extent of surface and resurfacing of dispersed oil

Suggestions to Address Knowledge Gaps:

- Short and long term collection of chemical data (oil and dispersant concentration) at the surface and subsurface
- Measurement of methane concentrations and flowrate throughout the water column
- Analysis of natural vs chemically enhanced dispersion in the subsurface and surface

On day two, Group A was divided into two subgroups; Group A1 examined the efficacy and effects of surface water application, while A2 examined the efficacy and effects of subsurface application.

Input to RRTs: Group A1 – Surface Application:

1. Surface application of dispersants has been demonstrated to be effective for the DWH incident and should continue to be used.
2. The use of chemical dispersants is needed to augment other response options because of a combination of factors for the DWH incident (i.e., continuous, large volume release)
3. Winds and currents may move the oil toward sensitive wetlands
4. Limitations of mechanical containment and recovery, as well as *in situ* burning
5. Weathered DWH oil may be dispersible. Further lab and field studies are needed to assess the efficacy and effectiveness and optimal dispersant application (e.g., multiple dispersant applications)
6. Spotter airplanes are essential for good slick targeting for large scale aerial applications (e.g., C-130), so their use should be continued
7. In order to most effectively use the assets available, the appropriate vessels or aircraft should be selected based on the size and location of the slick and condition of oil. Vessels and smaller aircraft should be used to treat smaller slicks and the weathered DWH oil because they can target more accurately and repeatedly. Larger aircraft should be used for larger fresh oil slicks offshore except in the exclusion zone around the source. A matrix of oil location, oil patch slicks size and condition, dispersant technique/dosage, visual guidance, requirements for success/confirmation has been developed by the dispersant assessment group in Houma incident command. This matrix should be reviewed by the RRTs.

Risks of Input to RRTs:

Dispersants will not be 100% effective. The matrix referencedabove contains information to maximize the efficacy of dispersant application on different states of the DWH oil. Dispersants redistribute the oil from the surface to the water column which is a tradeoff decision to be made by the RRT.

Benefits of Input to the RRTs:

Dispersing the oil reduces surface slicks and shoreline oiling. The use of chemical dispersants enhances the natural dispersion process (e.g., the smaller droplet size enhances potential biodegradation). Dispersing the oil also reduces the amount of waste generated from mechanical containment and recovery, as well as shoreline cleanup.

Possible Monitoring Protocols for Surface Water Application:

1. There is a good correlation between Tier 1 observations and Tier 2 field fluorometry data. There has been sufficient Tier 1 and 2 data collected for the DWH incident to indicate monitoring is not required for every sortie.
2. Going forward it is important to now focus on assessing the extent of the 3D area after multiple applications of dispersant at the surface. A sampling and monitoring plan to do this has been developed by the dispersant assessment group based in the Houma command center and initial implementation has begun. The RRT 6 should review this plan.

Input to RRTs: Group A2 – Subsurface Application:

1. The subsurface dispersant dosage should be optimized to achieve a Dispersant to Oil Ratio (DOR) of 1:50. Because conditions are ideal (i.e., fresh, un-weathered oil) a lower ratio can be used, reducing the amount of dispersant required. The volume injected should be based on the minimum oil flowrate, however an accurate volumetric oil flowrate is required to ensure that the DOR is optimized.
2. If we assume a 15,000 bbls/day oil rate and a 1:50 DOR, then actual dispersant flowrate is roughly similar to the current application rate of 9 GPM.
3. To further optimize dispersant efficacy, the contact time between dispersant and oil should be maximized. Longer contact time ensures better mixing of oil and dispersant prior to being released into the water, and should result in better droplet formation.
4. Contact time can be increased by shifting the position of the application wand deeper into the riser, optimizing nozzle design on the application wand to increase fluid sheer, and increasing the temperature of the dispersant to lower viscosity.
5. Effectiveness should be validated by allowing for a short period of no dispersant application followed by a short time of dispersant usage to look for visual improvements in subsurface plume.

Risks of Input to RRTs:

Dispersants are never 100% effective. The flow rate of oil out of the damaged riser is not constant, and significant amounts of methane gas are being released. Because the effective DOR is a function of oil flow rate, changes in the oil flow rate may significantly impact the actual DOR. If the DOR is too low, dispersion may not be maximized, while if it is too high, dispersant will be unnecessarily added to the environment. Assumptions are based on knowledge at standard temperatures and pressures (STP), while conditions at the riser are significantly different. Group members suggested that the oil escaping the damaged riser may be in excess of 100°C, and it is unclear what effect this has on the dispersant, or the efficacy or effectiveness of droplet formation. These conditions may drastically alter fluid behavior. Finally, there is an opportunity cost of changes to application wand position and development and deployment of a new nozzle.

<u>Benefits of Input to the RRTs:</u>

When optimized, subsurface dispersant application may reduce or eliminate the need for surface dispersant application, and will reduce surface and resurfacing of oil. Optimized subsurface dispersant application will likely promote formation of smaller, more stable droplets of oil, theoretically allowing quicker biodegradation.

<u>Possible Monitoring Protocols for Subsurface Application:</u>

1. In the absence of a reference control group, measurement should be made on the surface and subsurface to detect dispersant and dispersed oil to gauge the effectiveness of subsurface dispersant application. Currently, no known technique exists for accurately measuring part per billion concentrations of dispersant in seawater, and novel applications of GC-MS/GC-FID or UVFS + LISST may be required.
2. Tier 1 visual monitoring at the surface with quantification of oil with aerial remote sensing
3. Visual monitoring may be able to qualitatively demonstrate differences between dispersant application and no application (e.g., plume shape, color).

B. Physical Transport/ Chemical Behavior of Dispersed Oil

Group B was focused on the physical transport and chemical behavior of dispersed oil. While the initial goal was to look at these characteristics for chemically dispersed oil, the scope of the deepwater horizon incident required looking at both chemically and naturally dispersed oil.

Group members included:

Group Lead: Bruce Hollebone, Environment Canada
Recorder: Tyler Crowe, Coastal Response Research Center
Les Bender, Texas A&M
Mary Boatman, Minerals Management Service
Michel Boufadel, Temple University
Robert Carney, Louisiana State University
Jim Churnside, U.S. EPA
Greg Frost, U.S. EPA
Jerry Galt, Genwest
Buzz Martin, Texas General Land Office
Allan Mearns, NOAA
Scott Miles, Louisiana State University
Erin O'Riley, Minerals Management Service
Jim Staves, U.S. EPA

Information Required to Make an Assessment and Knowledge Gaps:

- Contact efficiency between dispersant and oil
- Release rate of oil and gas
- Dispersion efficiency
- Mixing energy at injection point
- Dispersion at depth (pressure effects)
- Temperature of released oil
- Weathering of oil in rising plume (dissolution, vapor stripping)
- Emulsion formation and dispersion under pressure
- Destabilization of emulsions as pressure decreases
- Emulsion formation in the rise zone before it hits the surface
- Biodegradation rate on droplets at pressure and at bottom temperature
- Sedimentation of dispersed oil from depth
- Biological uptake
- Surface Langmuir circulation potential for mixing
- Surface advection rates versus oil discharge to determine buildup potential
- BTEX levels above oil slick
- Suppression of airborne VOCs when using dispersants
- Airborne concentrations of 2-butoxy ethanol from spring
- Atmospheric breakdown and toxicity of 2-butoxy ethanol and other products

Current State of Knowledge:

- Surface models are effective and continuously improving
- SMART protocols are improving
- Increase of sampling at depth
- Well researched region (oceanographic and ecological studies)
- Well established baseline data
- Airborne application protocols are established
- Improved NEBA for dispersant use

Suggestions to Address Knowledge Gaps:

- Review Norwegian experiments
- Review literature on Ixtoc I
- Increase in remote sensing of the dispersed area
- Use of smaller grid sizes on models
- Increased offshore surface sampling, either as increased SMART sampling or separate sampling regime
- Development of fixed stations or boat water quality monitoring in the operational zone
- Establishment of criteria for discontinuance of dispersant operations
- Further research on the contact efficiency between dispersant and oil
- Better understanding of release rate and temperature of oil and gas
- Quantification of mixing energy at injection point
- Better coupling between offshore and onshore hydrodynamic models (LaGrangian vs. Eulerian)

- Investigation of dispersion efficiency at depth (pressure effects)

Input to RRTs:

1. Create an on-scene environmental review committee to advise SSCs that will be responsible for providing immediate operational and scientific advice, and aid in dispersant selection. This committee should be comprised of government agencies and academia that meet regularly.
2. Clearly define geographic area/water volume of concern. This will improve estimates for scale of impact (1st order approximation). This is important for NEBA analysis, and is based on current application rates, and maximum concentrations in the water volume.
3. Establishment of a more comprehensive sampling and monitoring program to understand transport. This can be done by implementing 24 hour monitoring stations (fixed to stationary positions such as other drill rigs).

Risks of Input to RRTs:

Continued dispersant use trades shoreline impacts for water column impacts. This increases the uncertainty of the fate of the oil, and potentially increases the sedimentation rate.

Benefits of Input to the RRTs:

Continued dispersant use reduces the threat distance, protects shorelines, likely increases the biodegradation rate of the oil, inhibits formation of emulsions, reduces waste management, and potentially reduces buildup of VOCs in the air.

Possible Monitoring Protocols for Subsurface Application:

1. Measure size and shape of the plume with and without subsurface injection of dispersant in order to have a better understanding of the efficacy. Sonar monitoring of plume size and morphology (tilt) can be used; increases in plume size suggest greater dispersion
2. Additional monitoring in the rising plume at a variety of depths to improve transport modeling and development of boundaries and constraints on estimates.
3. Additional monitoring of water temperature, particle size distribution, fluorescence monitoring of dispersant concentration, and total petroleum hydrocarbons (TPH).
4. Increase surface layer water quality monitoring (profile of upper 10 m) to address concerns of cumulative loading of water with oil and dispersant. Size of the monitoring zone will vary with advection and dispersant application. Should monitor for TPH, PAHs, dissolved oxygen, salinity, temperature, biological oxygen demand (BOD), VOA, and possible surfactant monitoring and toxicity testing.
5. Further air monitoring of surface water quality zone to gain a better understanding of volatilization and risk to responders. Monitoring should include BTEX and VOC concentrations, and while COREXIT 9527 is being used, 2-butoxy ethanol.

C. Biological Effects of Dispersants on Deep Ocean Species

Group C considered the biological effects and exposure pathways of dispersants applied to the subsurface. Group members included:

Group Lead: Zachary Magdol, Coastal Response Research Center
Recorder: Mike Curry, Coastal Response Research Center
Adriana Bejarano, Research Planning Inc.
Richard Coffin, Naval Research Laboratory
William Conner, NOAA Office of Response and Restoration
Charlie Henry, NOAA, Scientific Support Coordinator for USCG District 8
Ken Lee, Environment Canada
Jeffrey Short, Oceana
Ron Tjeerdema, University of California

Information Required to make assessment:

- Receptor species/species at risk
- Identify species at risk including their migration, feeding habits, life histories, reproductive strategies/recruitment
- Dispersant effect on oxygen levels and biogeochemical cycles in the deep water ecosystem
- Maximum rates of application
- Nutrient recycling, general efficiency of food chain
- What is the particle size distribution as a function of depth
- Biodegradation rates, microbial structure and function
- Look at seasonal dynamics of oxygen demand
- Scavenging particle interactions, oil-mineral aggregate formation at source and throughout water column
- Transport dynamics of deep water ocean currents
- Rate of water absorption
- Unknown latent effects (e.g., persistence)
- Biogeochemical and habitat data about ecosystems near natural deep water seeps
- Percent effectiveness of the seafloor dispersant application
- Further research on where dispersion occurs in the water column
- Changes in microbial degradation due to selective metabolism from addition of dispersants
- Effectiveness of natural dispersion
- Knowing the downstream flux of oil residue from the spill to the seafloor

Current State of Knowledge:

- Minerals Management Services, Gulf of Mexico deep water studies/reports: http://www.gomr.mms.gov/homepg/regulate/environ/deepenv.html
- Cordes et al., *Macro Ecology of Gulf of Mexico Cold Seeps*
- Natural hydrocarbon seepage in the Gulf of Mexico approximately 40 million gallons per year
- Some knowledge and past studies on deep water species in the Gulf of Mexico

- Preliminary modeling
- Preliminary monitoring data (Fluorometry data, Particle size analysis, Temperature, Salinity, D.O., Hydrocarbon, Acute toxicity , Acoustic data, sonar, Genomics)
- Deep water microbial structure, UC Berkley
- *None of the info listed above is considered "complete"

<u>Knowledge Gaps:</u>

- Preliminary models not validated
- Life history of benthic biota
- Migratory patterns and residence time of deep water species
- Microbial degradation rates on deep ocean hydrocarbon seeps
- Dispersant and dispersed oil byproducts
- Chronic toxicity of benthic biota
    - Comparison of bioaccumulation/bioavailability between different droplet sizes
    - Comparison of toxicity and environmental impact of natural vs chemically enhanced dispersed oil
- Species avoidance of oil

<u>Suggestions to Address Knowledge Gaps:</u>

- Formulation of biogeochemical rates with respect to fuel transport and sedimentation
- Early life stage studies, laboratory or cage studies
- Robust toxicity studies for deep water species

<u>Input to RRTs:</u>

1. Dispersant risk assessment should consider volume of DWH incident relative to natural seepage
2. There is a net benefit to continued subsurface dispersant use and application should continue

<u>Risks of Input to RRTs:</u>

Dispersant use increases the extent of biological impacts to deep water pelagic and/or benthic organisms, including oxygen depletion, release of VOCs into the water column, and toxicity. This may lead to changes in the diversity, structure and function of the microbial community, leading to changes in trophic level dynamics and changes to key biogeochemical cycles.

<u>Benefits of Input to the RRTs:</u>

- Surface impacts vs. water column impacts
- Observed reduction in volatile organics at surface
- Enhances the interaction between oil and suspended particulate material
- Accelerated microbial degradation through increased bioavailability
- Rapid recovery of downward sulfate diffusion and upward methane diffusion related to shallow sediment geochemistry

- Based on current knowledge, subsurface dispersant use confines the aerial extent of impact
    - Current impact zone is less than 50 km radius
- Reduction in emulsified oil at the surface
- Reduction of phototoxic impacts

<u>Possible Monitoring Protocols for Surface Water Application:</u>

1. Robust deep ocean toxicity studies
    - Application of research done with acute toxicity on forams, possibility of chronic studies (LC50, EC50)
    - Identify control areas
    - Cage studies in the plume
    - Identify surrogate/indicator species for impacts over a range of trophic levels
    - Identify key species of concern (migratory species)
    - Microbial genomics
    - Long term biological effects for resident species with baseline information
2. Biogeochemical monitoring
    - Petroleum degradation rates (C14 labels)
    - Microbial production and function (3H thymodine/Genomics)
    - Community diversity (16S RNA)
    - Background parameters (DOC, POC, DIC, concentration and dC13)
    - Bioavailability of the oil as a function of particle size
3. Physical/chemical parameters
    - UV fluorometry (Including FIR)
    - Monitor the particle size distribution of the oil as function of space and time (LISST particle counters)
    - Current velocity (ADCP)
    - Chemical properties CTD (oxygen, salinity, pH, SPM)
    - Chemical properties of the oil as a function of space and time (GC-MS)
    - Potential of acoustic monitoring (3.5 and 12 khz)

D. <u>Biological Effects of Dispersants on Surface Water Species</u>

Group D focused on the effects of surface dispersant application on species in the top ten meters of the water column. Group members included:

Group Lead: Nicholle Rutherford, NOAA
Recorder: Heather Ballestero, University of New Hampshire
Carys Mitchelmore, University of Maryland
Ralph Portier, Louisiana State University
Cynthia Steyer, USDA
Mace Barron, U.S. EPA
Les Burridge, St. Andrews Biological Stn, Fisheries and Oceans Canada
Simon Courtenay, Gulf Fisheries Centre, Fisheries and Oceans Canada
Bill Hawkins, Gulf Coast Research Laboratory, USM
Brian LeBlanc,
Jeep Rice, NOAA
Doug Upton

Terry Wade, Texas A&M University

Information Required to make assessment:

- Spatial location of oil, dispersants, and species
- The levels of concern need to be noted (e.g., sensitive species life stages, exposure pathways, LC50's oil and dispersant constituents)

Current State of Knowledge:

- The oil is being dispersed in the top ten meters of the water column from surface dispersant application (fluorescence methods)

Knowledge Gaps:

- Effectiveness of dispersant
- Long term effects of dispersant exposure (carcinogenicity)
- Dispersed oil effects in an estuarine/riverine/pelagic environment
- Bioavailability, bioaccumulation

Suggestions to Address Knowledge Gaps:

- Develop a clearinghouse to facilitate access to baseline data being collected
- Know dose of exposure, effects, species present and tradeoffs with habitat protection
- Understand differences between dispersed vs. non-dispersed oil

Input to RRTs: Effects of Dispersant in the top 10 M.

1. Surface application of dispersants is acceptable. Transferring the risk from the surface to the top 10 m is the lesser of the many evils.
2. Additional monitoring is required to better model where dispersed oil is going. Long term (monthly) monitoring is required at a minimum, and should be conducted in a grid formation inshore to open ocean. Passive samplers (i.e., SPME) should be used in selected areas, while a active water sampling program should be implemented to measure dispersant and dispersed oil, dissolved oxygen, and standard CTD + chlorophyll concentrations, as well as selected bioassays.

Possible Monitoring Protocols:

1. Monitor below 10 m
2. Monitor surface to bottom across a transect from the shore to source
3. Deploy semi-permeable membrane device (SPMD), passive sampling, or oysters
4. Monitor concentration and exposure time to get a better understanding of effective dose
5. Use state of the art toxicity tests

E. Overall Input to RRTs

1. Chemical dispersants, mechanical recovery and *in situ* burning are components of an effective response to surface oil pollution.

2. Mechanical recovery is the preferred method of on water oil spill response because it removes the oil from the environment, but is not always effective due to environmental conditions (e.g., weather, waves).

3. No combination of response actions can fully contain oil or mitigate impacts from a spill the size and complexity of the DWH incident.

4. Toxicity must be considered when a decision is made to apply chemical dispersants.

5. The effects of using 2.5 MG of dispersants during the Ixtoc spill in ’79 (Jernelov and Linden, 1981) should be considered as part of the evaluation of the DWH incident.

6. It is the consensus of this group that up to this point, use of dispersants and the effects of dispersing oil into the water column has generally been less environmentally harmful than allowing the oil to migrate on the surface into the sensitive wetlands and near shore coastal habitats.

7. For the DWH spill, the RRTs should provide for a continual reevaluation of tradeoff options going forward. Because of the magnitude of the DWH spill and with the expectation of prolonged dispersant application, the RRTs should consider commissioning a Consensus Ecological Risk Assessment, or equivalent, including use of existing temporal and spatial data on the resources at risk and using the most current environmental data.

8. Dispersed oil should be tracked over time and space in combination with 3-D modeling in order to inform future decisions on the use of dispersants for the DWH incident

9. There are short term laboratory and modeling studies which can be done to aid operational decision making (e.g., effect of high oil temp, high ambient pressure, and the presence of methane on dispersion effectiveness).

10. Monitoring protocols have been used for the DWH incident, modified as needed, and should be further adapted as noted in the specific sections of this report in the event of continuing aerial and subsurface dispersant application.

F. Bibliography:

(1) Jernelov, A. and Linden, O. (1981). *A Case Study of the World's Largest Oil Spill*. Ambio, Vol. 10, No. 6, pp. 299-306

(2) Coastal Response Research Center (2006) Research & Development Needs For Making Decisions Regarding Dispersing Oil. http://www.crrc.unh.edu/dwg/dispersant_workshop_report-final.pdf